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(58) Field of search
B1D

(54) Edge Filter

(57) An edge filter comprises a plurality of helical coils 7, arranged end to end and axially extended by ram 11 to widen the filtering gaps between turns when the filter is backwashed. The ends of each coil are screwed on to spacing rings 3, and springs 9 are arranged between the rings 3 to urge them axially apart, thus ensuring that coils 7 are uniformly opened out when ram 11 withdraws end disc 4 instead of the opening out being confined to one end. Spring 10 at one end normally overcomes springs 9 to compress the coils 7, whose turns carry raised lands to define filtering gaps. Two such filters are arranged in parallel in respective housings, and each filter is backwashed with filtrate from the other, under control of a timer or differential pressure monitor.

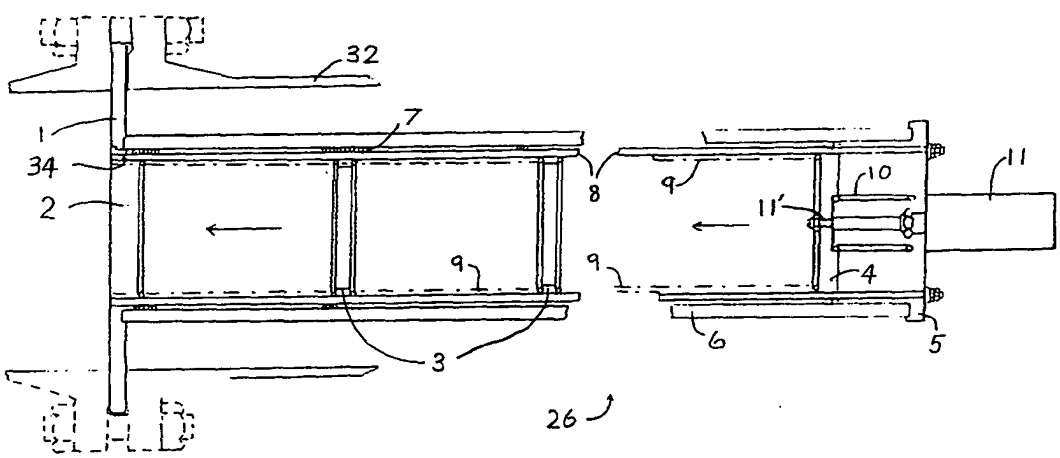

Fig 2

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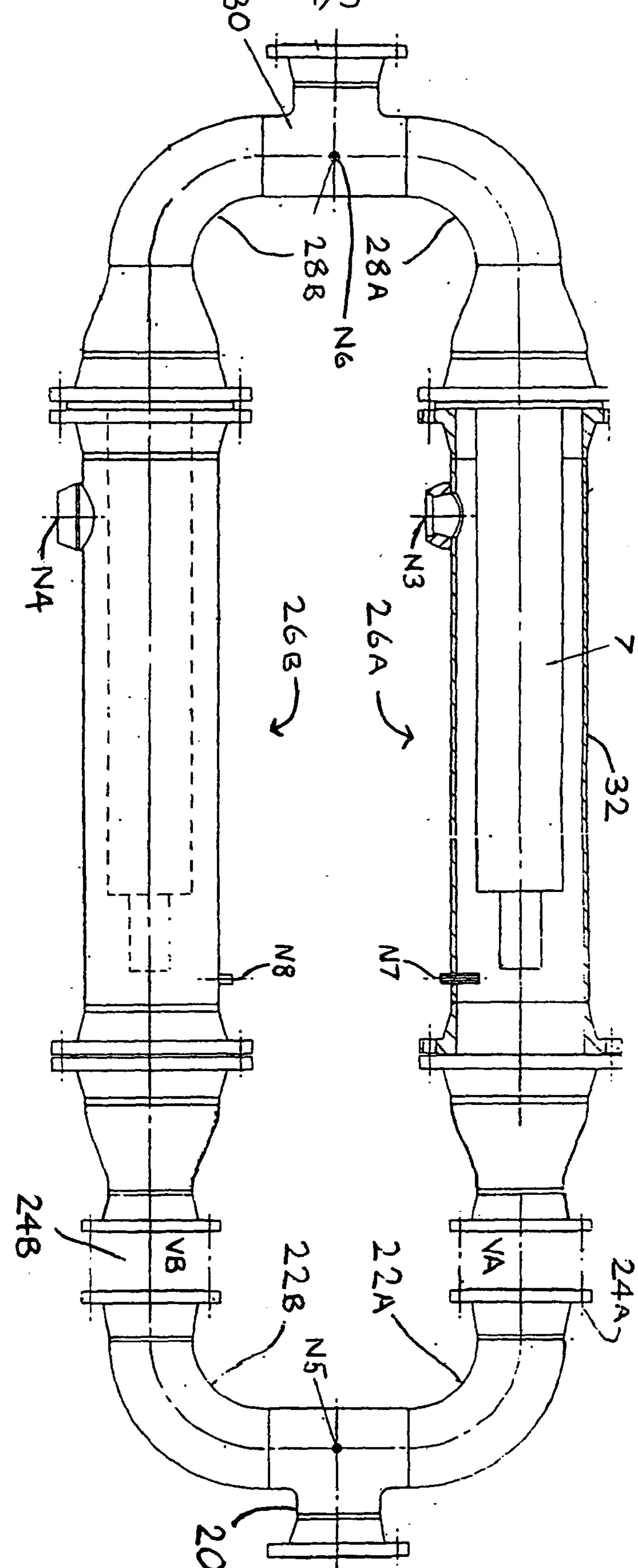


Fig 1

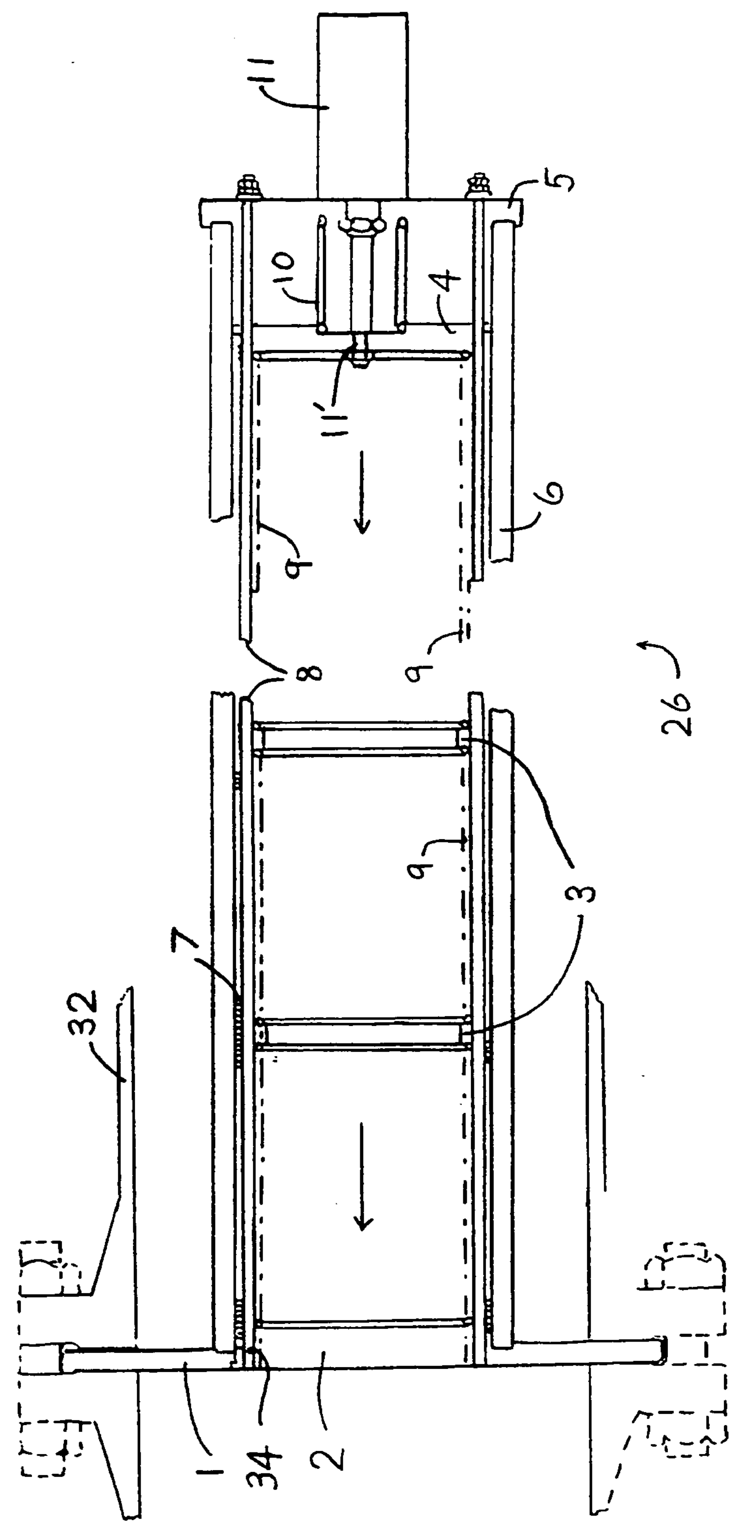


Fig 2

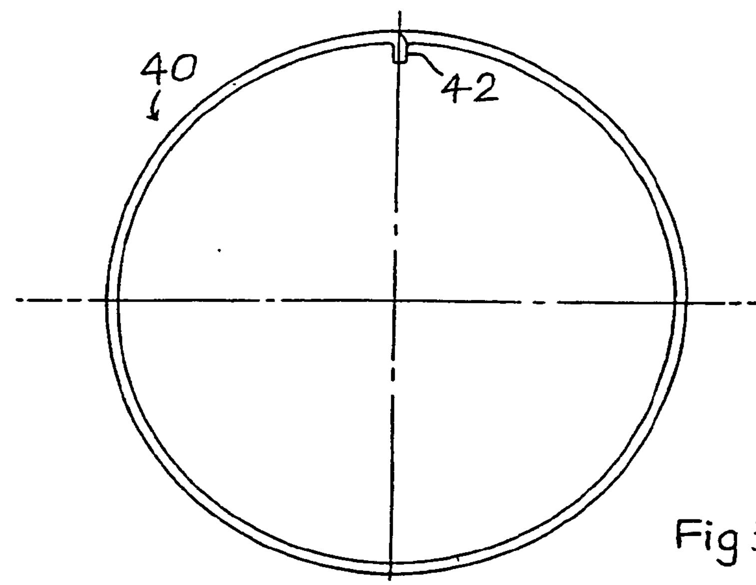
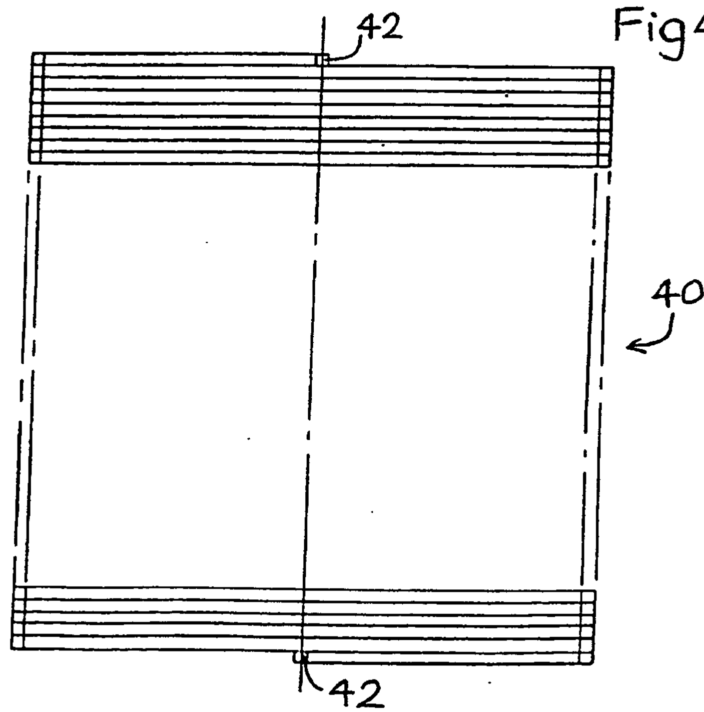


Fig 3

Fig 5

Fig4



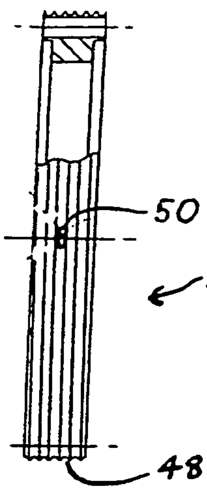


Fig6

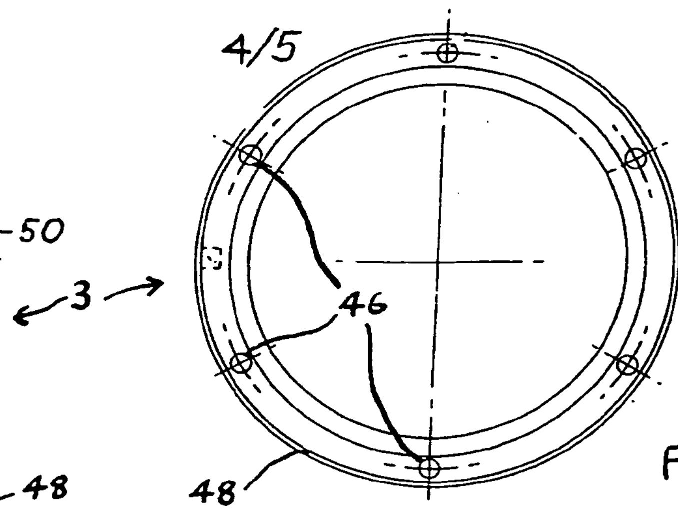


Fig 7

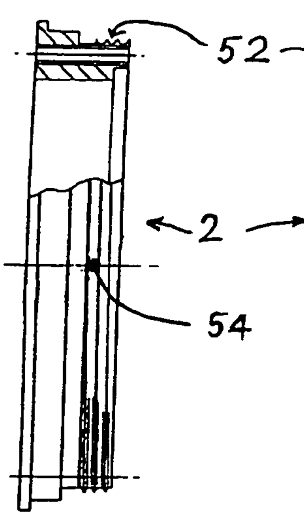


Fig 8

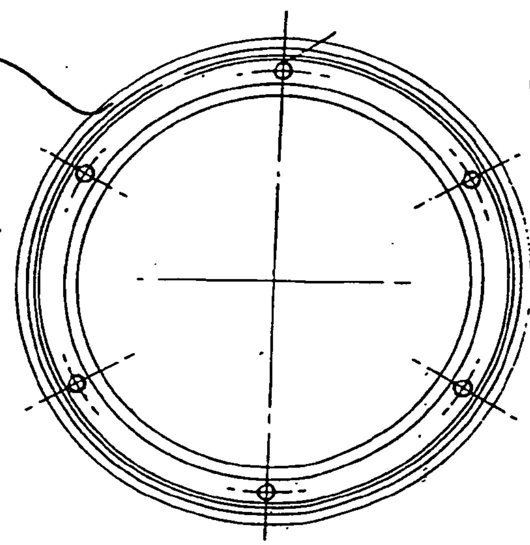


Fig 9

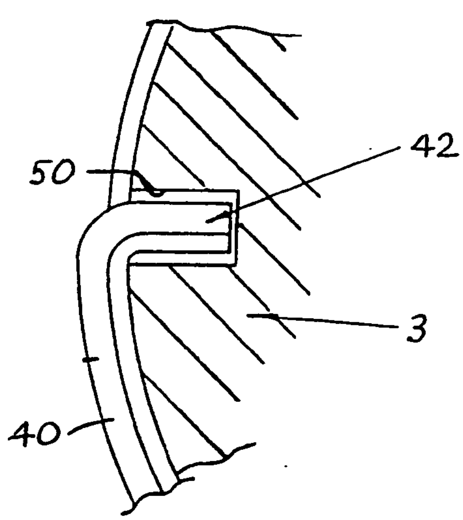


Fig 10

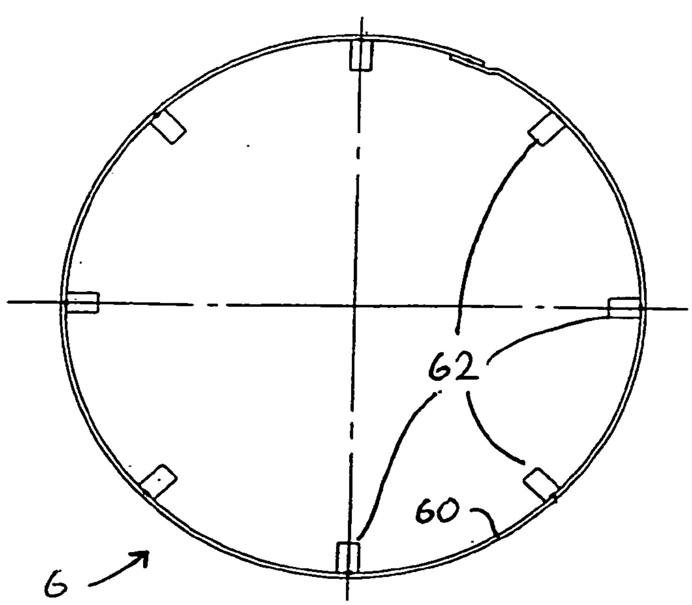


Fig 11

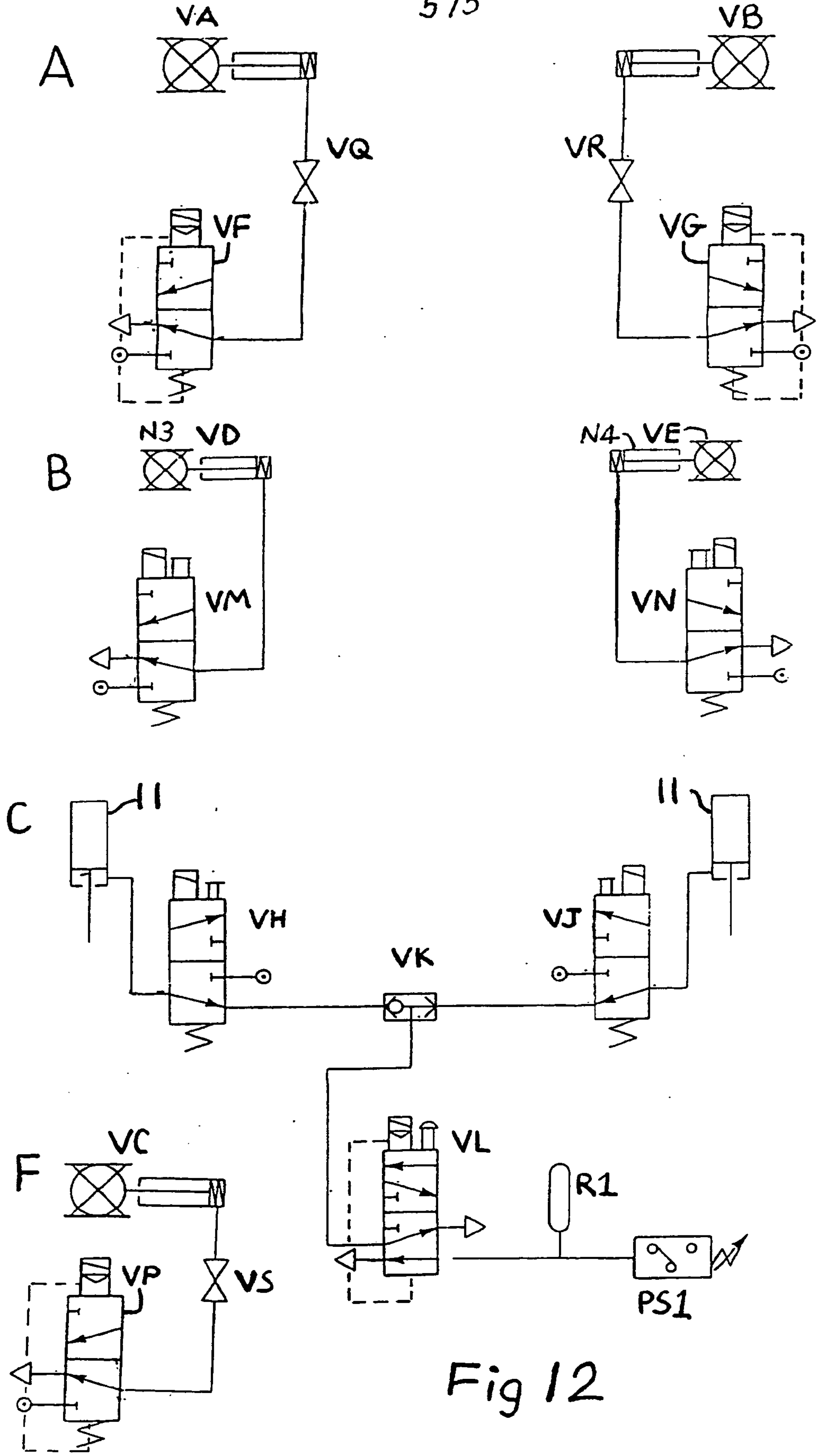

VA
A
VB
D
VQ
VR
VF
VG
N3 VD
N4 VE
B
E
VM
VN
C
11
11
VH
VJ
VK
VL
F
VC
R1
VP
VS
PS1

Fig 12

SPECIFICATION
Filtration of Fluids

The present invention relates to a method and apparatus for use in the filtration of fluids. It is particularly concerned with water filters for air conditioning systems for office blocks and the like.

A conventional air conditioning system for a large building makes use of large volumes of water which are recirculated, and which have to be passed through filters. These filters have to be capable of handling the large volumes, for long time periods without maintenance. Inevitably, any filter element tends to become clogged, and such systems have generally to incorporate means for automatically unclogging the elements.

A type of filter unit which is widely employed uses a cylindrical chamber containing a tubular filter screen of smaller diameter. Water is passed into the outer part of the chamber, and is filtered through the screen into the central portion, which communicates with an outlet. The filter screen is constituted by a helical coil which, in use, is in a compact configuration with adjacent turns nearly in contact. After some time, the screen becomes clogged. This leads to an increased pressure differential across the filter unit, which may be automatically detected. There upon a "backwash" cycle commences. Water is forced through the filter unit in the reverse direction, and the helical coil is extended somewhat, thus increasing the spacing between the turns.

This ingenious system works very well. However, the maximum size of coil which can be used can be severely limited. For the backwash cycle the coils are extended by the force of the backwashing water. But for a long coil, this would tend merely to extend the coil at one end region. For this reason, assemblies of filter units in parallel have been used, each unit employing a small coil.

The multiplicity of units tends to lead to complexity and expense. Furthermore if the water pressure is low, even short coils may not be extended properly. After the backwashing of a coil is complete, it is returned to its operative configuration by resumption of normal water flow. Thus for a short time dirty water can pass through the (partly) extended coil. Contaminant particles may become wedged between coil turns, so that the coil does not provide proper filtration.

According to the present invention in a first aspect there is provided a filter unit comprising: a filter screen which comprises an elongate coil; and a plurality of urging means along the length of the coil and coupled to respective longitudinal portions of the coil for urging extension thereof, so that if one end portion of the coil is displaced to extend the coil, said urging means cause substantially the whole coil to be extended.

The coil may comprise a plurality of coil portions coupled end to end via coupling elements. There may then be a said urging means for each coil portion, e.g. a compression spring which may act between adjac nt coupling elements.

In another aspect the invention provides a filtration assembly comprising an inlet conduit, an outlet conduit, two filter units (which may be as just described) connected in parallel, the units each having an inlet and an outlet, each inlet communicating via a respective valve with the inlet conduit and each outlet communicating with the outlet conduit; each unit also having a closable discharge port on the inlet side of the filter.

In a third aspect the invention provides a method of operating a filtration assembly according to the second aspect of the invention comprising alternating a filtration mode and a backwash mode, wherein in the filtration mode, a fluid to be filtered passes through the inlet conduit, is partitioned between the two filter units (the valves being open and the discharge ports being closed) and emerges via the outlet conduit; and wherein the backwash mode comprises shutting the valve and opening the discharge port of a first one of said filter units, and passing fluid through the inlet conduit and the second filter unit, at least some of the filtered fluid passing thence through the first filter unit to effect backwashing, and being discharged through the discharge port thereof.

A preferred embodiment of the present invention will now be described in greater detail with reference to the accompanying drawings in which:

Fig. 1 is a partly sectional elevation of a water filter assembly embodying the invention;

Fig. 2 is a sectional view on a larger scale through a filter unit of the assembly;

Figs. 3 and 4 are respectively end and side elevation of a filter coil;

Fig. 5 is an axial section through a single turn of the coil, not to scale;

Figs. 6 and 7 are side and end elevations of a spacer ring;

Figs. 8 and 9 are side and end elevations of a boss;

Fig. 10 is a detail of an axial section of a spacer on a large scale, showing the location of a coil;

Fig. 11 is an axial section through a filter cage assembly; and

Figs. 12A—F show pneumatic control circuitry.

The filter assembly shown in Fig. 1 has an inlet conduit 20 from which lead off two branch conduits 22A, 22B. Each of the branch conduits contains a closure valve 24A or B, and leads to the inlet end of a filter unit 26A or B. At the downstream end of the filter units 26A, B they communicate with respective outlet branch conduits 28A, B which lead to a common outlet conduit 30. The assembly will usually be upright, with the inlet conduit 20 uppermost.

A single filter unit 26 is shown in greater detail in Fig. 2. It is contained within an outer cylindrical casing 32. A the downstream end there is a base plate 1 located by flanges of the casing 32. The base plate 2 has a central aperture, and on its

upstream side a boss 2 is mounted. This is shown in greater detail in Figs. 8 and 9. A plurality (here 6) of rods 8 are secured to threaded apertures 34 distributed evenly around the periphery of the boss 2. The rods extend over the whole length of the unit 26. A filter coil assembly 7 is passed over the rods 8, there being a small amount of clearance between them. A top cap 4 has apertures for receiving the rods 8, and is fed onto them at the upper end. The filter coil assembly 7 is retained between the boss 2 and the top cap 4 in a manner which will be described later.

A perforated screen assembly 6 (which will be described more fully later) has the general form of a hollow cylinder whose internal diameter is slightly greater than the external diameter of the filter coil assembly 7. The screen assembly 6 is located concentrically about the coil assembly 7, and is mounted at its lower end in the base plate 1. Its upper end extends some way beyond the coil assembly 7 and top cap 4, and is mounted in an annular groove in a disc-shaped upper plate 5. The plate 5 has apertures for the rods 8. Their threaded ends extend beyond it, and each of them receives a crinkle washer and two nuts, by means of which the assembly is held rigidly together.

Between the top cap 4 and the upper plate 5, there is a strong compression spring 10 which urges the top cap 4 to slide along th rods 8 to compress the coil assembly 7. On the upper side of the upper plate 5, a single-acting pneumatic cylinder 11 is mounted. This has a piston rod 11′ which extends through an aperture in the upper plate 5, down the middle of the spring 10, and through an aperture in the top cap 4. The lower portion of the rod 11′ is threaded, and a nut is engaged thereon to abut the underside of the top cap 4. The rod 11′ is hollow, and hence communicates the interior of the filter unit with the non-working chamber of the pneumatic cylinder 11.

The structure of the filter coil assembly 7 will now be described in more detail. There are a multiplicity of coil elements 40, as shown in Figs. 3 to 5. Each element 40 is a generally helical coil of stainless steel wire having, at each end, a short, inwardly-directed nib 42. The cross-sectional form of the wire is shown in Fig. 5. It is basically six-sided, and may be regarded as a square with extra angled sides provided in space of two adjacent vertices, so that the section "points" radcwwly inwardly. This section is constant, but on one axially-facing side there are small raised portions 44 at regular intervals. Thus, when the element 40 is closed up (as shown in Fig. 4), adjacent turns are slightly spaced from one another, by a distance equal to the axial height of the raised portions 44. This spacing is the maximum size of a contaminant particle which will be allowed through the filter.

Betw en each adjacent pair of coil l ments 40, there is a spacer ring 3 (s e Figs. 2, 6 and 7). Each ring 3 is annular, with a thread on its radially outer face. The annulus has apertures 46 for the rods 8. The outer thread 48 is adapted to receive the inwardly projecting thread defined by coil elements 40 when closed up. (It is for this reason that the elements 40 have their inwardly-projecting cross-section). In a central portion of the thread 48, there is a radial slot 50 or pair of holes for receiving the nibs 42 of the adjacent pair of elements 40. Thus the coil assembly 7 has a substantially continuous coil.

The boss 2 has an analogous externally threaded portion 52 for location of the end coil element 40. It has a single hole 54 for receiving the end nib 42 thereof. Likewise, the top cap 4 has an externally threaded portion with a single aperture.

Within each coil element 40, extending between adjacent spacer rings 3 (or for the end elements 40, between one spacer ring 3 and the boss 2 or top cap 4) there is a compression spring 9, which urges displacement of the spacer rings to extend the coil element 40.

The perforated screen assembly 6 (Fig. 11) consists of a perforated sheet 60 and a multiplicity (here 8) of bars 62. The sheet 60 is formed into a cylinder, and the bars 62 extend axially of the cylinder on the inside. The radially inner surfaces of the bars 62 define the inner diameter of the assembly 6 which is, as mentioned above, slightly greater than the external diameter of the coil assembly 7. The screen assembly 6 serves as a coarse filter for removing relatively large debris from the water to be filtered.

In use for filtration, the filter unit 26 has the configuration shown in Fig. 2. The pneumatic cylinder 11 is not actuated, and its piston rod 11′ is in its extended position, under the influence of the compression spring 10. This spring 10 is strong enough to overcome the forces of the individual compression springs 9 associated with the individual coil elements 40, the counter-force due to the water pressure, and frictional forces tending to resist the movement of the coil assembly to the illustrated configuration. In order to achieve backwashing, the pneumatic cylinder 11 is actuated. This draws the top cap 4 upwardly, by means of the piston rod 11′, with compression of the spring 10. In the absence of the compression springs 9, the result of this would merely be to extend the upper portion of the coil assembly. But owing to the presence of the springs 9, all of the coil elements 40 extend to take up the space created by the displacement of the top cap. Each coil element 40 extends by essentially the same amount, which is equal to the displacement of the top cap divided by the number of coil elements. Thus the turns of the coil elements 40 are now mutually spaced by distances substantially greater than the height of the raised portions 44, and reverse passage of water can flush away the accumulated contaminants.

Referring to Fig. 1, during normal filtration the valves VA and VB are open.Water pass s in through the conduit 20, and reaches the filter elements 26A and B via the branch conduits 22A

and B. It enters the outer cylindrical casings 32 externally of the filter units 26A, B. It is then forced through the screen assembly 6 and coil assembly 7 of each unit 26, passing into the central void volume. Thence it passes to the outlet branch conduits 28A, B via the aperture in the boss 2. The filtered water from both branch conduits 28A, B passes out through the outlet conduit 30.

The inlet and outlet conduits 20, 30 have small output nozzles N5 and N6 respectively for connection to a differential pressure switch. The outer casings 32 of the filter elements have respective large outlet nozzles N3, N4. When the differential pressure switch detects that the pressure drop across the filter assembly has risen to a level indicating substantial clogging of the filter elements, backwashing is initiated. The valve VA in one of the inlet branch conduits 22A is closed. Then the pneumatic cylinder 11 of filter unit 26A is actuated to extend the filter coil assembly of that unit. The nozzle N3 in its outer casing 32 is opened. Thus water filtered through filter unit 26B enters the outlet side of the unit 26A, passes into the central void volume, and thence flows in the reverse direction through the filter coil assembly 7 and the perforated screen assembly 6, before being discharged from the nozzle end 3. (There may be a valve VC to close off the outlet conduit 30 during backwashing, but this may not be necessary. The pressure therein may be sufficient to cause backwashing of one filter element even while still allowing some outward flow).

After a predetermined time, nozzle N3 is closed again. Actuation of the pneumatic cylinder 11 ceases, and so the filter coil assembly is returned to its closed state by the action of the compression spring 10. (Means for ensuring that this happens properly are described later). Once the coil assembly 7 is again in its working configuration, the valve VA is reopened. The cycle then repeats for the filter unit 26B.

Most of the components of the filter assembly are preferably made of stainless steel, though some components such as the spacer rings 3 could be made of a rigid plastics material such as P.V.C., and the compression springs 9, 10 may be of beryllium copper. The perforated screen assembly 6 may be produced from a perforated sheet 60 to which stainless steel bars are welded. The sheet is then rolled into a cylinder, and spot welded. The springs 9 associated with the coil elements 40 have spring forces sufficient to overcome the weight of the coil elements 40, the spacer rings 3 and the top cap 4, together with any friction in the assembly.

The pneumatic cylinders 11 are single-acting, and receive their actuating compressed air via nozzles N7, N8 in the cylindrical casing 32. Note that the displaced fluid in the pneumatic cylinders 11 is filtered water from the c ntre of the filter units, drawn in and rejected via the hollow rod 11′.

The operation of the apparatus may be controlled automatically. One possibl arrangement for achi ving this, which mak s use of an electronic unit and an array of pneumatically operated valves, will now be described with reference to Fig. 12. It will be appreciated that many other arrangements are possible, for example, using hydraulic in place of the pneumatic elements.

When an excessive pressure drop across the filter assembly is detected by the differential pressure switch (as mentioned above), an electrical signal is sent by the electronic control unit to the valve VF (Fig. 12A), whereupon it switches to direct compressed air to the pneumatically operated valve VA (in the branch conduit 22A in Fig. 1) to close this valve. After a slight delay to allow this to happen, signals are sent to valves VH and VM (Figs. 12C and 12B respectively), which pneumatically act respectively on the pneumatic cylinder 11 of filter unit 26A (to extend the coil assembly 7), and valve VD (to open the nozzle N3 in the casing 32 of filter unit 26A). Thus backwashing of filter unit 26A commences. This continues for a set time (which may be arranged to be a function of the water pressure, and hence of the flow rate through the filter assembly).

Then valves VH and VM are switched back to their previous configurations, so that the nozzle N3 is closed (due to valve VM). Air from the pneumatic cylinder 11 then exhausts via valve VH, which switches a shuttle valve VK to allow the air to pass to valve VL. This was automatically switched at the end of said preset time so that the air passes through it to reservoir R1 and to pressure switch PS1. The pressure switch PS1 is tripped when it detects a predetermined pressure which indicates that the pneumatic cylinder 11 has emptied fully. It then sends a signal to the control board, which then (a) switches valve VL to allow the reservoir R1 to exhaust, and (b) allows valves VH and VK to exhaust. Valve VF (Fig. 12A) returns to its normal position, so that the valve VA in the conduit 22A opens, and flow through filter unit 26A resumes. The control unit then sends a signal to valve VG (Fig. 12B) and a corresponding half cycle occurs for backwashing filter unit 26B, by means of the pneumatic circuitry shown in Figs. 12D, E and C.

If in either half cycle the pressure switch PS1 does not detect the preset pressure, this means that the corresponding pneumatic cylinder 11 has not closed up properly, so that the filter coil assembly 7 is still somewhat extended. This might occur if a large particle became wedged in the turns. If the filter element were then to be returned to use in filtration, improperly filtered water would be discharged by the filter assembly. Therefore, a warning is activated, and the system may be automatically closed down.

The electronic control unit may have a control panel including switches for operating the valve VA, VB, VC (if present), VD and VE, and for initiating a backwash cycle, for overriding the automatic control. There may also be a counter

for counting the number of backwash cycles which have occurred, lamps and/or audible alarms for faults, and a differential pressure gauge.

As shown in Figs. 12A, D and F, there may be manual stop valves VQ, VR and VS for holding the valves VA, VB and VC in their closed positions even if the electric supply to valves VF, VG and VP is cut off.

It will be noted that there are several safety features in the assembly. Apart from the manual override valves and switches, we may mention the arrangement of the filter units 26 in which the filter coil assemblies are mechanically urged into their closed, filtering configurations by the strong springs 10, so that no failure of an electrical or pneumatic control should lead to unfiltered water leaving the system. Furthermore, the system for detecting the complete emptying of the pneumatic cylinders 11, employing the pressure switch PS1, provides a further safeguard. Of course, this system could be applied to any device that must sense both volume and pressure (for a pneumatic system), or volume (for a hydraulic system).

It will be appreciated by the skilled reader that the invention can be embodied in many different ways. For example, a multiple coil unit generally as illustrated in Fig. 2 could repy on water pressure to effect extension (as in the prior art), instead of a separate actuating means. An assembly need not use two units as illustrated, but could use one, or more than two. With plural units, it will generally be preferred for just one unit to be backwashed at a time.

The invention has been described with reference to a water filter assembly, but it is not restricted thereto. Other fluent materials including gases, may be filtered using methods and apparatus embodying the invention.

CLAIMS

1. A filter unit comprising: a filter screen which comprises an elongate coil; and a plurality of urging means along the length of the coil and coupled to respective longitudinal portions of the coil for urging extension thereof, so that if one end portion of the coil is displaced to extend the coil, said urging means cause substantially the whole coil to be extended.

2. A filter unit according to claim 1 wherein the coil comprises a plurality of coil portions coupled end to end via coupling elements.

3. A filter unit according to claim 2 wherein said plurality of urging means comprises, for each coil portion, a respective spring means which acts between the coupling elements associated with that coil portion.

4. A filter unit according to claim 2 or 3 wherein each coupling element has a generally cylindrical external face provided with a thread which provides a seat for portions of adjacent coil portions.

5. A filter unit according to claim 4 wherein each coupling element has an aperture in its external face for receiving inwardly projecting end portions of both of the associated coil portions.

6. A filter unit according to any preceding claim wherein the coil has a plurality of spaced projections which extend axially to limit the closeness of approach of adjacent turns.

7. A filter unit substantially as described herein with reference to and as illustrated in the accompanying drawings.

8. A filtration assembly comprising an inlet conduit, an outlet conduit, two filter units connected in parallel, the units each having an inlet and an outlet, each inlet communicating via a respective valve with the inlet conduit and each outlet communicating with the outlet conduit; each unit also having a closable discharge port on the inlet side of the filter.

9. A filtration assembly according to claim 8 wherein each filter unit is a filter unit according to any of claims 1 to 7.

10. A filtration assembly according to claim 8 or 9 having means for monitoring the pressure drop across the filter units.

11. A filtration assembly according to claim 10 having means for automatically performing a backwash cycle for a filter unit in response to detection of an excessive pressure drop, said means acting to close the inlet valve and open the discharge port of the filter unit.

12. A filtration assembly according to claim 11 wherein the filter unit is a unit according to any of claims 1 to 7, and said automatic backwash means actuates extension of its coil.

13. A filtration assembly substantially as described herein with reference to and as shown in the accompanying drawings.

14. A method of operating a filtration assembly according to any of claims 8 to 13 comprising alternating a filtration mode and a backwash mode, wherein in the filtration mode, a fluid to be filtered passes through the inlet conduit, is partitioned between the two filter units (the valves being open and the discharge ports being closed) and emerges via the outlet conduit; and wherein the backwash mode comprises shutting the valve and opening the discharge port of a first one of said filter units, and passing fluid through the inlet conduit and the second filter unit, at least some of the filtered fluid passing thence through the first filter unit to effect backwashing, and being discharged through the discharge port thereof.

15. A method of operating a filtration assembly substantially as described herein with reference to the accompanying drawings.

16. A filter unit, filtration assembly, or method according to any preceding claim wherein the or each filter unit includes a filter screen which is extendible to facilitate backwashing and is provided with means for actuating extension and subs qu nt recompression, and means for monitoring the recompression.

17. A unit, assembly or method according to claim 16 wherein the actuating means comprises a piston and cylinder operated by a working fluid, and the fluid discharged from it on recompression is monitored by said monitoring means.

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